

UNIVERSAL FAMILY SPACERS FOR A BATTERY ELECTRICAL  
PROTECTION DEVICE

CROSS REFERENCE TO RELATED APPLICATION

5       The present application claims priority from  
provisional application Serial No. 60/422,199, filed  
October 30, 2002.

BACKGROUND OF THE INVENTION

10       This invention relates generally to devices for  
protecting an electrical component, and more particularly  
to a protection device for a circuit board connected to an  
electrochemical cell or battery.

15       Protection devices are known for protecting an  
electrical component, such as a fuse and diode assembly,  
mounted on an electrochemical cell. According to the  
present invention, a protection device housing a circuit  
board mounted on an end of the cell is provided with a  
cylindrical spacer ring. The spacer ring surrounds and  
captures the protective device so that a standard shrink-  
20       wrap material is suitable for securing the spacer and,  
consequently, the protective device to the cell. By  
providing spacers rings in various sizes for variously  
sized cells, the protection device is standardized.  
Examples of protection devices, sometimes referred to as  
25       snap-cap devices, for an electrical component connected to  
an electrochemical cell are found in U.S. Patents Nos.  
6,205,034, 6,317,335 6,426,867, and 6,437,239, all to  
Zayatz, and 6,617,953 and 6,618,273, both to Zayatz et

al., the disclosures of which are hereby incorporated by reference.

#### SUMMARY OF THE INVENTION

5           The present invention provides a relatively inexpensive family of spacers of various sizes for securing a standardized terminating electrical protection device (such as one of the "snap-cap" type) to an electrical energy power source (i.e., a lithium  
10       electrochemical cell). The terminating protection device is mounted on the cell header and contains a circuit board provided with electrical components, such as diodes and fuses. The function of the circuit board is generally to protect the cell from being overcharged or too rapidly  
15       discharged, and the like.

          Conventional practice is to provide the terminating protection device sized for a particular sized cell. However, this means that separate devices must be manufactured and stocked for each cell size. The present  
20       spacers eliminate this stocking problem. The spacers are sized to take up the space between the edge of the cell and the edge of the terminating protection device. That way, only variously sized spacers need to be stocked. The spacers are relatively simple to manufacture and  
25       inexpensive to stock. For example, the same terminating protection device sized for a "C" sized cell can be used on a "D" sized cell, and larger, by providing a spacer taking up the space between the edge of the larger cell and the terminating protection device.

These and other aspects and advantages of the present invention will become increasingly more apparent to those skilled in the art by reference to the following description.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded view of a protective housing 36 including a terminal cap 68 mounted on a cell 10.

Fig. 2 is a perspective view of the protective housing 36 mounted on the cell casing 12 shown in Fig. 1.

Fig. 3 is a side elevational view of the protective housing 36 shown in Fig. 1 mounted on an oversized cell casing 12A with the aid of a spacer ring 78 according to the present invention.

Fig. 4 is an enlarged view of the indicated area in Fig. 3.

Fig. 5A is a top plan view of the spacer ring 78 shown in Figs. 3 and 4.

Fig. 5B is a side elevational view of the spacer ring 78

Fig. 5C is a bottom plan view of the spacer ring 78.

#### DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, Fig. 1 is an exploded view of an electrochemical cell 10 comprising a casing 12 closed by a lid or header 14 to house the electrochemical components therein. While not shown in the drawing, the cell comprises an anode active material and a cathode active material segregated from each other by a separator and activated with an electrolyte. The cell is not

intended to be limited to any particular chemistry, and can comprise a solid anode/solid cathode type or a solid anode/liquid depolarizer type. The cell can be of either a primary or a secondary chemistry. Exemplary chemistries  
5 include lithium/iodine, lithium/silver vanadium oxide, Li-ion cells, and the like.

In any event, the cell is typically built in a case-negative configuration having the anode electrically connected to the casing 12 and header 14 as the negative  
10 terminal and the cathode electrically connected to a terminal pin 16. The terminal pin 16 is electrically isolated from the casing 12 and header 14 by an insulating glass 18 forming a glass-to-metal seal. The cell can also be built in a case-positive configuration having the  
15 cathode connected to the casing and header and the anode connected to the terminal pin.

A circuit board 20 having any one of a number of electrical components, such as a fuse 22 and diode 24, is mounted on the cell header 14. The exact electrical  
20 components and their configuration are not necessarily part of the present invention and depend on the intended application of the cell 10. The present invention is, however, directed to protecting the electrical components of the current board 20 from shock and vibration  
25 conditions, and the like, regardless of their exact function and configuration.

The fuse 22 and diode 24 are supported on a substrate 26 of an insulating material. The substrate 26 has an aperture 28 sized to receive the terminal pin 16 when the  
30 circuit board 20 is mounted on the cell header. In this

position, the terminal pin 16 is connected to a first lead 30 having one of its ends disposed immediately adjacent to the aperture 28 perimeter. That way, when the circuit board 20 is supported on the cell header with the terminal pin 16 extending through the aperture 28, a weld is used to connect the first lead 30 to the terminal pin 16. The other end of the lead 30 is connected to an electrical trace (not shown) embedded in or provided on the substrate 26.

A second lead 32 has its proximal end connected to the substrate 26. The distal end of this lead is for connecting to the cell header serving as the negative terminal for the case-negative cell 10. Similarly, a third lead 34 is provided with its proximal end connected to an electrical trace (not shown) embedded in or provided on the substrate 26. The distal end of this lead is for connecting to a terminal for the terminal pin 16, as will be described in detail hereinafter.

In order to protect the circuit board 20 from damage, for example, if the cell is used to power a downhole tool in an oil well logging or drilling operation, a protective housing 36 is provided. A material that is suitable for the protective housing 36 is a polyamide sold by E.I. du Pont de Nemours and Company under the trademark ZYTEL® (Nylon 6/6) 70G33L. Other suitable materials include VICTREX® (PEEK) 450-G manufactured by Victrex USA Inc. of Westchester, Penn., a polyamide-imide available from DSM Engineering Plastic Products, Inc. of Reading, Penn., as TORLON® 4203 PAI, a material marketed under the name KETRON® PEEK 1000 by DSM Engineering Plastic Products,

Inc., and a liquid crystal polymer market as ZENITE® by E.I. du Pont de Nemours and Company.

5 In the embodiment shown in Figs. 1 and 2, the protective housing 36 has a base 38 of a size and shape that substantially matches that of the cell header 14. Since the exemplary cell is housed in a cylindrical casing 12, the base 38 is circular with a centrally located aperture 40 therethrough. However, it is within the scope of the present invention that the base 38 can have other  
10 multi-sided shapes, such as square, rectangular, octagonal, and the like. The shape of the base 38 need not necessarily match that of the cell header.

The base 38 supports a plurality of arcuate projecting shoulders 42 spaced at intervals about the  
15 periphery thereof. The projecting shoulders 42 comprise an outer wall 44 and an inner wall 46, both extending upwardly to an upper surface 48. The plane of the upper surface 48 is substantially parallel to the plane of the base 38. The plurality of outer walls 44 are spaced  
20 inwardly from the outer periphery of the base 38 to provide a ledge 50, the purpose of which will be described hereinafter.

Upwardly extending retaining clips 52 are supported on the base 38 between each pair of adjacent projecting  
25 shoulders 42. The retaining clips 52 comprise an outer wall 54 and an inner wall 56, each wall extending upwardly to an inwardly projecting hook portion 58. The hook portion 58 comprises an angled wall 60 that slopes downwardly and inwardly toward the base aperture 40 to  
30 terminate at a planar bottom wall 62. The plane of the

bottom wall 62 is substantially parallel to the plane of the base 38 and spaced above the upper planar surfaces 48 of the projecting shoulders 42. The junction where the angled wall 60 meets the bottom wall 62 of each retaining clip 52 is spaced somewhat outwardly toward the base perimeter in relation to the inner wall 46 of the projecting shoulders 42. The plurality of outer walls 44, 54 of the respective projecting shoulders 42 and retaining clips 52 are substantially at an equal radius from the base aperture 40.

To facilitate manufacturing the retaining clips 52, for example by injection molding, molding orifices 64 are preferably provided in the base 38. The molding orifices 64 allow a portion of a mold to extend through the base 38 to form the bottom wall 62 of the retaining clips 52. Once the retaining clips 52 are formed, the mold is withdrawn through the molding orifices 64.

The protective housing 36 is mounted on the cell header 14 with the terminal pin 16 received in the base aperture 40. The circuit board 20 is supported on the base 38 of the housing 36 with the terminal pin received in the aperture 28 thereof.

A compressible pad 66 and terminal cap 68 complete the protective housing. The compressible pad is preferably a silicone-based material capable of withstanding temperatures up to at least about 200°C. A silicone based material suitable for the compressible pad 66 is available from Furon Company of New Haven, Connecticut as product number R10470 and referred to by the trademark COHRLASTIC®.

The pad 66 is sized to fit snugly inside the inner wall 46 of the projecting shoulders 42 with a thickness from the upper surface of the circuit board 20 to the retaining clips 52. The terminal cap 68 is shaped to match the shape of the inner walls 56 of the retaining clips 52. The outer peripheral edge of the terminal cap 68 is sized to extend beyond the inner walls 46 of the projecting shoulders 42 to contact the inner walls 56 of the retaining clips 52 in a close-fitting, releasable relationship.

After the compressible pad 66 is positioned inside the protective housing 36 resting on the circuit board 20, the terminal cap 68 is inserted into the protective housing 36 over the pad to rest on the upper surface 48 of the projecting shoulders 42. Since the retaining clips 52 are of a resilient material, they flex backwardly enough to accommodate this movement, and then snap back into their original position to capture the terminal cap 68 confined between the projecting shoulders 42 and the retaining clips 52. The terminal cap 68 can be removed without damage to the protective housing 36, if necessary.

The terminal cap 68 is preferably of a conductive material, such as stainless steel or nickel, and includes an upwardly projecting boss 70. The previously described third lead 34 from the circuit board is bent to curl up and over the top of the terminal cap 68 and welded, soldered, or otherwise secured thereto. This electrically connects the terminal cap 68 to the cell's terminal pin 16.



As shown in Fig. 1, the cell header 14 is provided with a projection 72 spaced from the terminal pin 16. The projection 72 is received in a second aperture 74 (shown in dashed lines) in the base 38 of the protective housing 36. This further prevents rotational movement of the protective housing 36 relative to the cell 10 and header 14. Furthermore, a thin NOMEX<sup>®</sup> disc (not shown) with double sided high temperature adhesive may be used to secure the protective housing 36 to the header 14.

Fig. 2 is a perspective view of the protective housing 36 including the terminal cap 68 mounted on the cell header 14. As shown, the outer peripheral edge of the base 38 of the protective housing 36 is substantially equal to the size of the cell header 14. The ledge 50 formed between the plurality of outer walls 44, 54 of the respective projecting shoulders 42 and the retaining clips 52 provides a structure for securing the protective housing 36 to the cell 10. While not shown in the drawings, a cylindrically shaped piece of shrink-wrap polymeric material is positioned over the casing sidewall to extend upwardly beyond the ledge 50. The shrink-wrap is then heated, such as by a hot-air gun. This causes the shrink-wrap material to become semi-liquid and then shrink down onto the cell and protective housing, lying over the ledge 50 as it cools. In this position, the deformed shrink wrap locks the protective housing 36 down onto the cell header 14.

It is a primary aspect of the present invention to standardize the shape of the protective housing 36, compressible pad 66, terminal cap 68 and circuit board 20.

That way, the same size parts can be used regardless of the size of the cell. For example, while Fig. 2 shows a cell 10 that has substantially the same peripheral size as the protective housing 36, that is not necessary. Figs. 3 and 4 show a cell 10A comprising a cylindrical casing 12A having a peripheral size substantially larger than the periphery of the protective housing 36. In these figures, the circuit board, compressible pad, terminal cap, and projecting shoulders of the protective housing 36 are not shown for the sake of simplicity. The cell 10A can be of a similar or different chemistry as the cell 10 shown in Figs. 1 and 2.

In order to secure the undersized protective housing 36 to the header 14A for cell 10A, a spacer 78 is provided. As shown in Figs. 5A to 5C, the spacer 78 is generally a ring shaped member having a circular outer wall 80 and a circular inner wall 82. The coaxial outer and inner walls 80, 82 extend to a planar upper surface 84. The junction of the outer wall 80 and a lower surface 86 forms a step 88. A ledge 90 is provided at the junction of the inner wall 82 and the planar bottom surface 86. With the protective housing 36 resting on the cell header 14A having the cell terminal pin 16A received in the base aperture 40 of the protective housing 36, the ledge 90 is sized to surround and capture the step 50 of the protective housing. The step 88 of the spacer 78 is disposed adjacent to the periphery of the cell header 14A. Then, when the previously described shrink-wrap polymeric material is heat-shrunk down and onto the spacer 78 and its step 88, the spacer is secured to the cell. The

spacer, in turn, helps secure the protective housing 36 to the cell.

Thus, it can be seen that cells of a wide variety of sizes can be provided with a stock protective housing 36, compressible pad 66, terminal cap 68 and circuit board 20. The spacer 78 is provided in a variety of sizes to take up the space between the step 50 of the protective housing 36 and the peripheral edge of the cell. That way, there only needs to be a variety of spacer sizes kept in stock and not a variety of protective housings, compressible pads, terminal caps and circuit boards. This greatly facilitates economy of assembly, as less different sized parts are needed to build cells of different sizes to meet customer requirements.

It is appreciated that various modifications to the inventive concepts described herein may be apparent to those skilled in the art without departing from the spirit and the scope of the present invention defined by the hereinafter appended claims.